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Examination

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(54) ACTUATION MEDIUM MIXTURE

[There are no amendments to this patent.]

CLAIMS

1. Actuation medium mixture characterized by using pentafluoroethane and at least one substance chosen from n-butane, isobutane, cyclobutane, n-pentane, isopentane, and cyclopentane as an indispensable component.

DETAILED DESCRIPTION OF THE INVENTION

Industrial Application Field

This invention relates to a new actuation medium mixture that can be used for refrigerators, heat pumps, etc.

Description of the Prior Art

Air-conditionings units, freezer storage units, and refrigeration devices (refrigeration cycle - heat pump cycle), waste-heat-recovery power generation (Rankine cycle), heat exchange devices (heat pipe), etc., are put in practical use or are being trial-developed. Water and hydrocarbons such as propane or butane, trichlorofluoromethane (R11), chlorofluorocarbons such as chlorodifluoromethane (R22), or ammonia, etc., are known as the actuation medium used for these devices.

Problem(s) to be Solved by the Invention

Chlorofluorocarbons have low toxicity and are chemically stable with non-flammability; since various chlorofluorocarbons with different standard boiling points can be easily obtained, evaluation research of these as the actuation medium have been actively conducted. This invention newly offers chlorofluorocarbons with excellent heat recovery efficiency, in particular, [to be used in] freezers, refrigerators, air conditioning devices, hot-water supply devices, or heat-pump systems for exhaust heat recovery.

Means for Solving the Problem

The present invention is an actuation medium mixture characterized by using pentafluoroethane (hereinafter referred to as R125) and at least one substance chosen from n-butane, isobutane, cyclobutane, n-pentane, isopentane, and cyclopentane as an indispensable component.

The following explains the present invention in further detail in reference to Figure 1, showing the flow sheet of the refrigeration cycle system using the actuation medium mixture (hereinafter, it may only be referred to as an actuation medium) of the present invention. In Figure 1, 1 represents a compressor, 2 a condenser, 3 and 3' piping for load fluids, 4 a decompression device, 5 an evaporator, and 6 and 6' piping for heat-source fluids.

After an actuation medium in the refrigeration cycle system shown in Figure 1 is compressed with compressor 1, it is led to condenser 2, and is cooled and condensed with the load fluid introduced from tubing 3 in said condenser 2. On the other hand, a load fluid is conversely heated in condenser 2, and is taken for load heating through tubing 3'. After the actuation medium condensed subsequently is decompressed with decompression device 4, it is then led to evaporator 5; it is introduced from tubing 6 in said evaporator 5, and after it is heated with the heat-source fluid discharged from tubing 6', it is again drawn by compressor 1 and the above-mentioned cycle is repeated. On the other hand, the heat-source fluid is conversely cooled in evaporator 5 and taken for cooling through tubing 6'.

Figures 2 and 3 represent a pressure enthalpy chart of the cycle of the actuation medium mixture in the refrigeration cycle system shown in Figure 1. When adiabatic compression of the saturated steam of an actuation medium is carried out, Figure 2 shows the one under moist conditions and Figure 3 shows that under dry conditions.

The change of the actuation medium with respect to the compressor of Figure 1 corresponds to the change of [designated by] 8-9 or 13-14 of Figures 2 and 3, respectively; the change of the actuation medium with respect to the condenser corresponds to the change of 9→10→11 or 14→15→16→17; the change of the actuation medium with respect to the decompression device corresponds to the change of 11 to 12, or 17 to 18; the change of the actuation medium with respect to the evaporator corresponds to the change of 12 to 8, or 18 to 13.

The end temperature of evaporation (temperature 7 or 13, hereinafter referred to as the evaporation temperature) of an actuation medium in an evaporator under the operating conditions of the refrigeration cycle system of Figure 1 using the actuation medium mixture of the present invention, and the beginning temperature of the condensation (temperature 9 or 15, hereinafter referred to as the condensation temperature) of the actuation medium in a condenser were set. Tables 1 to 6 shows the coefficient of performance and the refrigeration capacity per compressor unit volume, along with comparative examples, of said refrigeration cycle system that used the actuation medium mixture of the present invention.

As can be understood from the table, the actuation medium mixture of the present invention that uses R125 and at least one substance chosen from the hydrocarbons with 4-5 carbon atoms, in particular n-butane, isobutane, cyclobutane, n-pentane, isopentane, and cyclopentane, as an indispensable component can be significantly improved compared with the case wherein R125 is used independently; specifically, the actuation medium mixture in which the composition of R125 is approximately 20 mol% is greatly improved compared with the case wherein R125, n-butane, isobutane, cyclobutane, n-pentane, isopentane, or cyclopentane is independently used, respectively. Although the hydrocarbon with 4-5 carbon atoms, which is one of the constituents of the actuation medium mixture of the present invention, has a high coefficient of performance compared with R125, it has drawbacks: the refrigeration capacity per compressor unit volume is low and it is flammable. On the other hand, although R125 has the drawback of a low coefficient of performance compared with the hydrocarbon with 4-5 carbon atoms, it possesses the advantages of being non-flammable and having a high refrigeration capacity per compressor unit volume; using it in the actuation medium mixture of the present invention shows that it is very effective, because each drawback can be improved and the advantages can be efficiently employed.

Although the actuation medium mixture of the present invention is particularly effective in the refrigeration cycle application of low- to high-temperature air-conditionings, freezer storage units, as well as refrigerators, it can also be used as an actuation medium in heat recovery techniques of various kinds, such as the Rankine cycle. The actuation medium mixture of the present invention has excellent thermal stability and does not require a stabilizer in anticipated-use environments; however, in case of severe-use environments where an improvement of the thermal stability is required, approximately 1 part by weight of stabilizer such as phosphite compounds, for example, dimethyl phosphite, diisopropyl phosphite, diphenyl phosphite, etc., or thio phosphite compounds, phosphine sulfide compounds, for example, triphenylphosphine sulfide, trimethylphosphine sulfide, etc., or glycidyl ethers, can be added in a small amount to 100 part by weight of the actuation medium.

Table 1 (Evaporation Temperature: -20°C, Condensation Temperature: 40°C, Supercooling degree: 0°C)

R125a/mole ratio of n-butane	100/0	90/10	80/20	70/30	50/50	20/80	0/100
Coefficient of performance (-)	2.48	2.64	2.78	2.97	3.32	3.58	3.26
Refrigeration capacity (kcal/m^3)	345	300	240	200	150	110	80

Table 2 (Evaporation Temperature: -20°C, Condensation Temperature: 40°C, Supercooling degree: 0°C)

R125/mole ratio of isobutane	100/0	90/10	80/20	70/30	50/50	20/80	0/100
Coefficient of performance (-)	2.48	2.62	2.73	2.86	3.14	3.36	3.16
Refrigeration capacity (kcal/m^3)	345	320	285	250	200	150	115

Table 3 (Evaporation Temperature: -20°C, Condensation Temperature: 40°C, Supercooling degree: 0°C)

R125/mole ratio of cyclobutane	100/0	90/10	80/20	70/30	50/50	20/80	0/100
Coefficient of performance (-)	2.48	2.62	2.83	3.10	3.52	3.85	3.53
Refrigeration capacity (kcal/m^3)	345	250	185	150	110	75	55

Table 4 (Evaporation Temperature: -20°C, Condensation Temperature: 40°C, Supercooling degree: 0°C)

R125/mole ratio of n-pentane	100/0	90/10	80/20	70/30	50/50	20/80	0/100
Coefficient of performance (-)	2.48	2.50	2.98	3.34	3.86	4.29	3.34
Refrigeration capacity (kcal/m^3)	345	135	85	65	45	30	20

Table 5 (Evaporation Temperature: -20°C, Condensation Temperature: 40°C, Supercooling degree: 0°C)

R125/mole ratio of isopentane	100/0	90/10	80/20	70/30	50/50	20/80	0/100
Coefficient of performance (-)	2.48	2.49	2.91	3.25	3.77	4.18	3.31
Refrigeration capacity (kcal/m^3)	345	170	115	90	65	45	30

Table 6 (Evaporation Temperature: -20°C, Condensation Temperature: 40°C, Supercooling degree: 0°C)

R125/mole ratio of cyclopentane	100/0	90/10	80/20	70/30	50/50	20/80	0/100
Coefficient of performance (-)	2.48	2.51	3.05	3.39	3.89	4.41	3.59
Refrigeration capacity (kcal/m^3)	345	90	60	45	30	20	10

Effect of the Invention

The actuation medium mixture of the present invention is particularly excellent with respect to the refrigeration cycle efficiency, i.e., refrigeration and heating efficiency, and its extensive improvements compared with pentafluoroethane are acknowledged.

Brief Description of the Drawings

Figure 1 shows a flow sheet of the refrigeration cycle to explain one application example of the present invention. Figures 2 and 3 are drawings of the pressure enthalpy chart showing the cycle that used the actuation medium mixture of the present invention.

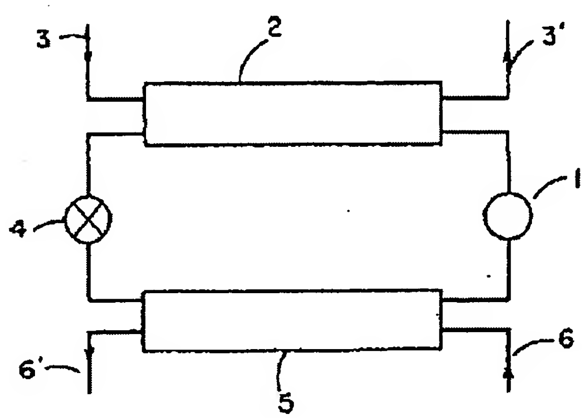

Figure 1

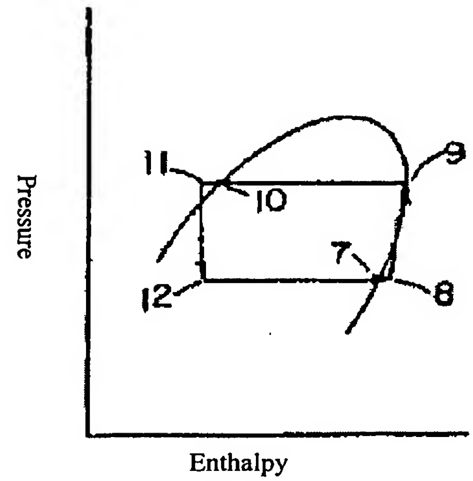

Figure 2

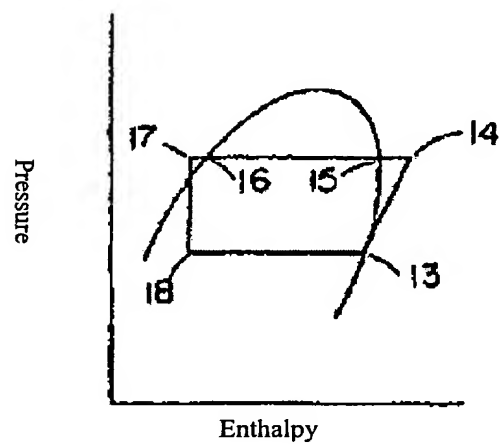

Figure 3

Language Services Unit
Phoenix Translations
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